REMARKS

This amendment is responsive to the Office Action that was mailed July 15, 2003. The form of this Amendment is the Revised Amendment Format under 37 C.F.R. § 1.121 that became effective July 30, 2003.

Claim Amendments

Claim 1 has been amended to incorporate limitations of claim 2. In particular, claim 1 now recites that the reforming stack includes a plurality of cylindrical vessels each of which is stackable without the need for connecting piping between the vessels. This amendment does not introduce any new matter and support for the amendment is found in original claim 2, and in the specification as filed on page 12, lines 7-25.

New claims 13-16 have been added. These new claims do not introduce any new matter and support for the subject matter recited is found in original claims 1, 2, and 4, and in the specification as filed on page 12, lines 7-25, and on page 15, lines 10-12.

Rejection of claims under 35 U.S.C. § 103(a)

Claims 1-3 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of *Hsu, et al.* ("*Hsu*") and *Frye, et al.* ("*Frye*").

Hsu discloses a thermally enhanced compact reformer that is a plate-type reformer wherein planar reforming elements are integrated with alternating planar fuel cell elements so as to utilize waste heat generated by the electrochemical reaction of the fuel cells in the reforming process. Referred to as an internal reforming electrochemical converter, the text of *Hsu* is clear in describing the converter as consisting of alternating layers of electrolyte and thermally conducting interconnector plates to promote heat transfer between the reforming and fuel cell components. These alternating plates are shown in clear detail in the exploded view of Figure 4.

It appears to be the position of the Office that "vessel" as used in Applicant's claims and specification is undefined and thus, that the term is entitled to be given the broadest *possible* interpretation. However, Applicant respectfully disputes that the term is undefined or not described. Specifically,

claim 1 as amended recites that the compact reformer comprises a reforming stack and a purification stack and that "the reforming stack includes a first plurality of cylindrical vessels, each of said first plurality of cylindrical vessels is stackable without the need for connecting piping between each vessel." Further, Applicant's specification describes a reforming stack of the present invention as:

> composed of individual modular units, which are separable, re-arrangeable and individually replaceable. While the modules can have any cross sectional configuration, such as circular, rectangular, triangular, etc., a circular cross section is preferred resulting in the reactor stacks having a generally tubular shape.

See Specification as filed, page 12, lines 7-25.

Furthermore, Applicant would point out that even if the term "vessel" were not explicitly defined, the construction of the term is limited to the broadest *reasonable interpretation consistent with the specification*. *See* M.P.E.P. § 2111. Applicant's specification describes the separable nature and rearrangeability of the vessels, their preferred orientation, cross sectional shapes, materials of construction, dimensions, and the variety of their contents such as but not limited to catalysts, inerts, heating elements, and heat exchangers. Further, it is explicitly described that each modular unit or vessel performs a separate operational function. As specifically described in reference to Figure 2, these operational functions can include anode tail gas oxidation, desulfurization, auto-thermal reformation, water gas shift reactions, and preferential oxidation reactions. See specification as filed, page 15, lines 10-28.

With respect to the plate-type reformer disclosed in *Hsu*, it is asserted by the Office that each plate acts as a "vessel." Paper 9, page 4. While the device in *Hsu* comprises vertical stacks of plates, and even illustrates that fuel and oxidizer may pass vertically through aligned openings provided in the plates, the reference describes that the reforming reaction actually occurs in the horizontal spaces (24) between the plates. See Figures 1-5 and text relating to the reforming reactant passages 24. Furthermore, a stacked reforming structure (13) of these plates is preferably enclosed in a gas-tight enclosure or housing (20). *See* column 4, lines 15-24. As such, there is no teaching or suggestion in *Hsu* that one of these plates is structurally or functionally a "vessel" as described in Applicant's specification, or more particularly, that a stack of these plates constitutes a "plurality of cylindrical vessels" as recited in amended claim 1.

There is no teaching or suggestion in the disclosure of *Hsu* that the plate-type internal reforming electrochemical converter disclosed therein could be modified into a fuel processor comprising dual reforming and purification stacks; or, more specifically, that the plate-type internal reforming electrochemical converter should be modified in the manner suggested by the examiner so that the reforming stack includes a plurality of cylindrical stackable vessels.

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The *Frye* reference discloses a hydrodesulfurization reactor for use in removing sulfur from heavy fuel oils during petroleum refining. Heavy fuel oils are described in the *Frye* reference as atmospheric resids, vacuum gas-oil and vacuum resids having boiling temperatures above 650°F. *See* col. 1, lines 6-21. Because *Frye* does not address nor is related to a process for reforming, purifying, and/or otherwise producing a hydrogen-rich gas suitable for direct delivery feed to a fuel cell, it does not pertain to the Applicant's field of endeavor. *See* M.P.E.P. 2141.01(a).

In addition, it should be noted that the production of a hydrogen-rich gas through fuel reforming does not typically utilize heavy fuel oil as a fuel feed to an autothermal reforming or steam reforming reactor. Note that Applicant's specification identifies reforming fuels including natural gas, LPG, gasoline, and diesel. *See* page 2, lines 13-15. As such, one skilled in the art would not have referred to a prior art reference that is specific to the desulfurization of heavy fuel oil for use in removing sulfur from a reforming fuel. Moreover, Applicant's specification describes that the sulfur components exiting the reforming reactor are in the form of hydrogen sulfide. *See* specification page 9, lines 3-16. As such, one skilled in the art would not have referred to a prior art reference that discloses a hydrodesulfurization process that forms hydrogen sulfide. *See* Petroleum Chemistry and Refining, Spreight, James G. (© 1998, Taylor & Francis), Chapter 6, "Heavy Oil Upgrading Processes," p. 152 (describing hydrodesulfurization as the thermal cracking of heavy oils in the presence of hydrogen and a catalyst to produce hydrogen sulfide). Therefore, the *Frye* reference represents non-analogous art, the teachings of which would not have been considered separately or in combination with the *Hsu* reference discussed above.

It has also been asserted by the Office that while the reaction in *Frye* does consume hydrogen, some hydrogen is recovered after desulfurization. Paper 9, page 4. However, it should be noted that there is no teaching or suggestion in *Frye* that any hydrogen is produced during the disclosed hydrodesulfurization process. The only source of hydrogen in *Frye* is hydrogen source 14. The hydrogen that is illustrated as being recovered through line 58 is recycled hydrogen that has been separated and scrubbed from the desulfurized product. *See* column 5, lines 2-7. Thus, there is no teaching or suggestion in *Frye* that hydrogen is generated or purified during or subsequent to the hydrodesulfurization reaction, nor is there any suggestion that the hydrogen that might be recovered is of a quality and/or quantity suitable for direct feed to a fuel cell, as is recited in Applicant's claims.

It is further asserted by the Office that *Frye* discloses a plurality of cylindrical vessels. Applicant respectfully disagrees. As illustrated in Figure 1 of *Frye*, reactor 24 includes catalyst beds 26, 28, 30, and 32. As noted in the discussion above concerning the *Hsu* reference, the term "vessel" as used in claims is not undefined or lacking description. Rather, Applicant's claim requires that the purification stack comprise a plurality of cylindrical vessels, each of which is stackable without the need for connecting piping. Further, Applicant's specification describes the separable nature and rearrangeability of the vessels, their preferred orientation, cross sectional shapes, materials of construction, dimensions and the variety of their contents such as but not limited to catalysts, inerts, heating elements, and heat exchangers. Moreover, it is explicitly described that each modular vessel performs a separate operational function. As such, although the catalyst beds illustrated in *Frye* are vertically aligned along a common axis, there is no teaching or suggestion that the disclosed hydrodesulfurization reactor should be assembled from a *plurality of stackable cylindrical vessels.*

In summary, Applicant maintains that *Frye* represents nonanalogous art, the teachings of which would not have been considered separately or in combination with those of *Hsu*. In addition, even if the teachings of both references are considered, neither discloses or suggests a reforming stack that is composed of a plurality of stackable cylindrical vessels. Likewise, neither of the

cited references when taken above or in combination discloses nor suggests a purification stack comprising a plurality of cylindrical vessels.

Applicant respectfully requests reconsideration and withdrawal of the rejection of Claims 1-3 under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of *Hsu, et al.* and *Frye, et al.*

Allowable Subject Matter

Applicant extends his gratitude for the examiner's comments concerning Claims 4-12 and the allowable subject matter contained therein. No amendments have been made in reference to Claims 4-12, as they are believed to be allowable because of their direct or indirect dependency from Claims 1 and 2 as discussed above.

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All of the stated grounds of objection and rejection are believed to have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicant believes that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Amendment is respectfully requested.

Respectfully submitted,

Frank C. Turner
Attorney for Applicant
Reg. No. 39,863

September 24, 2003
Chevron Services Company
1111 Bagby, Suite 4040
Houston, Texas 77002
(713) 752 3084 (voice)
(713) 752 7969 (fax)

D# 00045